Electronic Version
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Claims

[c1] 1. A method for producing adult aquatic specie in an aquaculture system comprising:

growing algae within an algae subsystem containing saltwater illuminated by a light source;

flowing the algae from the algae subsystem into an artemia subsystem containing adult artemia, an aquatic specie nursery subsystem and an aquatic specie growout subsystem, all containing saltwater;

consuming the algae by the adult artemia and producing small artemia by the adult artemia within the artemia subsystem;

passing the small artemia from the artemia subsystem to the aquatic specie nursery subsystem and the aquatic specie growout subsystem;

consuming the algae and the small artemia by immature aquatic specie contained within the aquatic specie nursery subsystem for producing adolescent aquatic specie, the adolescent aquatic specie being passed to the aquatic specie growout subsystem;

consuming the algae and the small artemia by the adolescent aquatic specie contained within the aquatic specie growout subsystem for producing

adult aquatic specie; and

harvesting the adult aquatic specie.

[c2] 2. The method of claim 1, further comprising filtering a waste outflow from the aquatic specie growout subsystem by a filtration subsystem for providing a saltwater return to the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem.

[c3] 3. The method of claim 1, further comprising controlling the aquaculture system with a data acquisition and control subsystem.

[c4] 4. The method of claim 1, further comprising replenishing saltwater lost in the aquaculture system due to evaporation and leakage.

[c5] 5. The method of claim 1, wherein the step of growing algae within an algae subsystem further comprises:

seeding a selected strain of algae into one or more containers containing saltwater;

illuminating the algae subsystem with a light source for proper algae growth;

maintaining a temperature of the algae and saltwater by a heater means;

measuring pH, algae density, temperature, light

source output, dissolved oxygen and micronutrients; and

controlling CO2 inflow for pH control, saltwater replenishment inflow, light source output, saltwater return inflow from a filtration subsystem, and algae outflow to the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem.

[c6] 6. The method of claim 5, wherein the selected strain of algae is selected from the group consisting of isochrysis galbana, nannochloropsis, dunaliella, skeletonema, thalassiosira, phaeodactylum, chaetoceros, cylindrotheca, tetraselmis, and spirulina.

[c7] 7. The method of claim 5, wherein the optimum saltwater return inflow value is selected to maintain an algae density value within a range of from 100 thousand to 10 million cells per milliliter of the preferred strain of algae.

[c8] 8. The method of claim 5, wherein the one or more containers is selected from the group consisting of open containers and sealed containers.

[c9] 9. The method claim 1, wherein the step of consuming algae by the adult artemia and producing small artemia by the adult artemia within the artemia subsystem fur-

ther comprises:

adding adult artemia to one or more containers containing saltwater;

illuminating the artemia subsystem with a light source for proper algae growth;

maintaining a temperature of the artemia, algae and saltwater by a heater means;

measuring waste, algae density, artemia density, temperature, pH, ammonia, light source output and dissolved oxygen; and

controlling oxygen inflow, saltwater return inflow from a filtration subsystem, light source output, saltwater replenishment inflow, algae inflow and artemia outflow to the aquatic specie subsystem.

[c10] 10. The method of claim 9, wherein controlling a saltwater return inflow value maintains an artemia outflow value to the aquatic specie nursery subsystem and the aquatic specie growout subsystem to adequately remove waste from the artemia subsystem and provide sufficient artemia to the aquatic specie nursery subsystem and the aquatic specie growout subsystem for food.

[c11] 11. The method of claim 9, further comprising preventing adult artemia from leaving the one or more containers of the artemia subsystem and allowing artemia waste and small artemia to pass from the one or more contain-

ers of the artemia subsystem to the aquatic specie nursery subsystem and the aquatic specie growout subsystem by filtering container outflow through a 400 micron screen.

[c12] 12. The method of claim 9, wherein the one or more containers is selected from the group consisting of open containers and sealed containers.

[c13] 13. The method of claim 1, wherein the step of consuming the algae and the small artemia by an immature aquatic specie contained within the aquatic specie nursery subsystem further comprises:

placing the immature aquatic specie in one or more containers in the aquatic specie nursery subsystem for consuming algae and artemia for producing adolescent aquatic specie;

illuminating the aquatic specie nursery subsystem with a light source for proper algae growth;

maintaining a temperature of the immature aquatic specie, algae, artemia and saltwater by a heater means;

measuring waste, algae density, artemia density, aquatic specie size, aquatic specie density, temperature, pH, ammonia, light source output, and dissolved oxygen;

controlling oxygen inflow, saltwater return inflow

from a filtration subsystem, light source output, saltwater replenishment inflow, artemia inflow from the artemia subsystem, algae inflow from the algae subsystem and waste outflow to the filtration subsystem; gradually increasing the saltwater level in the one or more containers for increasing a volume of the one or more containers as the immature aquatic specie increase from immature size to adolescent size; and enabling the adolescent aquatic specie to be passed through to the aquatic specie growout system.

[c14] 14. The method of claim 13, wherein the step of controlling the waste outflow to the filtration subsystem comprises filtering the waste outflow from the aquatic specie nursery subsystem through a filter screen to prevent immature aquatic specie from leaving the aquatic specie nursery subsystem and allowing waste products to pass to the filtration subsystem.

[c15] 15. The method of claim 14, wherein the filter screen comprises a 400 micron bottom section and a 800 micron top section for enabling disposal of increased waste products from increasing size aquatic specie as the effective volume of the aquatic subsystem is increased by adding increasing a saltwater level to accommodate the larger specie size.

[c16] 16. The method of claim 13, wherein controlling a salt-water return inflow value maintains a waste outflow value to the filtration subsystem by controlling volume to adequately remove waste from the aquatic specie sub-system.

[c17] 17. The method of claim 13, wherein the preferred aquatic specie is selected from the group consisting of litopenaeus vannamei, monodon, indicus, stylirostis, chi-nensis, japonicus, and merguiensis.

[c18] 18. The method of claim 13, wherein the optimum waste outflow rate from the aquatic specie nursery subsystem is selected to remove waste products from an aquatic specie density of from 0.25 to 0.5 pounds per gallon of saltwater.

[c19] 19. The method of claim 13, wherein the one or more containers is selected from the group consisting of open containers and sealed containers.

[c20] 20. The method of claim 1, wherein the step of consum-ing the algae and the small artemia by the adolescent aquatic specie contained within the aquatic specie growout subsystem further comprises:

containing the immature aquatic specie in one or more containers in the aquatic specie growout sub-

system for consuming algae and artemia;

illuminating the aquatic specie growout subsystem with a light source for proper algae growth;

maintaining a temperature of the adolescent aquatic specie, algae, artemia and saltwater by a heater means;

measuring waste, algae density, artemia density, aquatic specie size, aquatic specie density, temperature, pH, ammonia, light source output, and dissolved oxygen;

controlling oxygen inflow, light source output, saltwater return inflow from a filtration subsystem, saltwater replenishment inflow, artemia inflow from the artemia subsystem, algae inflow from the algae subsystem and waste outflow to the filtration subsystem; and

gradually increasing the saltwater level in the one or more containers for increasing a volume of the one or more containers as the adolescent aquatic specie increase from adolescent size to adult size.

[c21] 21. The method of claim 20, wherein the step of controlling the waste outflow to the filtration subsystem comprises filtering the waste outflow from the aquatic specie growout subsystem through a filter screen to prevent immature aquatic specie from leaving the aquatic specie

growout subsystem and allowing waste products to pass to the filtration subsystem.

[c22] 22. The method of claim 20, wherein the filter screen comprises a 2000 micron bottom section and a 5000 micron top section for enabling disposal of increased waste products from increasing size aquatic specie as the effective volume of the aquatic subsystem is increased by adding increasing a saltwater level to accommodate the larger specie size.

[c23] 23. The method of claim 20, wherein controlling a saltwater return inflow value maintains a waste outflow value to the filtration subsystem by controlling volume to adequately remove waste from the aquatic specie growout subsystem.

[c24] 24. The method of claim 20, wherein the optimum waste outflow rate from the aquatic specie growout subsystem is selected to remove waste products from an aquatic specie density of from 0.25 to 0.5 pounds per gallon of saltwater.

[c25] 25. The method of claim 20, wherein the one or more containers is selected from the group consisting of open containers and sealed containers.

[c26] 26. The method of claim 2, wherein the step of filtering a

waste outflow from the aquatic specie growout subsystem comprises:

pumping the waste outflow from the aquatic specie growout subsystem to an input of a first mechanical filter;

flowing a first part of an outflow from the first mechanical filter to an inflow of a biofilter, an outflow of the biofilter being connected to a saltwater return inflow of the aquatic specie nursery subsystem and a saltwater return inflow of the aquatic specie growout subsystem;

flowing a second part of the outflow from the first mechanical filter to an inflow of a second mechanical filter, an outflow of the second mechanical filter being flowed through an inflow heating passage of a heat exchanger to a pasteurization chamber inflow;

pasteurizing the pasteurization chamber inflow from the heat exchanger for destroying living organisms in the inflow and flowing a pasteurization chamber outflow to an outflow cooling passage of the heat exchanger; and

flowing a pasteurized and cooled outflow from the heat exchanger outflow cooling passage to a saltwater return inflow of the algae subsystem and a saltwater return inflow of the artemia subsystem.

[c27] 27. The method of claim 26, further comprising adding supplemental nutrients to the pasteurization chamber outflow under control of a data acquisition and control subsystem.

[c28] 28. The method of claim 26, further comprising sterilizing the flow conduits from the heat exchanger cooling passage to the saltwater return inflow of the algae subsystem and the saltwater return inflow of the artemia subsystem using a steam sterilizer under control of a data acquisition and control subsystem.

[c29] 29. The method of claim 3, wherein the step of controlling the aquaculture system comprises:

connecting measurements from the algae subsystem, artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem to an input multiplexer;

connecting an output from the input multiplexer to an input of a microprocessor;

connecting an output of the microprocessor to a controller output;

connecting an output from the output controller to controls for the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem, the aquatic specie growout subsystem and the filtration subsystem; and

connecting the microprocessor to a video monitor and keyboard for providing a user interface.

[c30] 30. The method of claim 1, wherein the aquaculture system comprises a closed recirculating system.

[c31] 31. The method of claim 1, wherein the harvested adult aquatic specie is shrimp.

[c32] 32. The method of claim 1, further comprising positioning habitat structures within the aquatic specie nursery subsystem and the aquatic specie growout subsystem for increasing the number of aquatic specie in the subsystem by providing a greater habitat surface area.

[c33] 33. The method of claim 1, further comprising:

maintaining a temperature value in the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem within a range of from 23°C to 32°C;

maintaining a salinity value in the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem within a range of from 20 to 45 parts per thousand;

maintaining a dissolved oxygen value in the artemia subsystem, the aquatic specie nursery subsystem

and the aquatic specie growout subsystem within a range of from 4.5 to 9.0 parts per million;

maintaining a pH value in the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem within a range of from 7.5 to 8.5; and

adjusting an illumination level of light sources for the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem for regulating algae growth rates.

[c34] 34. The method of claim 1, wherein the step of passing the small artemia further comprises passing the small artemia and adult artemia from the artemia subsystem to the aquatic specie nursery subsystem and the aquatic specie growout subsystem.

[c35] 35. A method for producing adult aquatic specie in an aquaculture system, comprising:

growing algae in saltwater;

feeding the algae to artemia in saltwater;

producing artemia by the artemia in saltwater;

feeding the algae and the artemia to an immature aquatic specie in saltwater to produce adult aquatic specie; and

harvesting the adult aquatic specie from the saltwa-

ter when mature.

[c36] 36. The method of claim 35, wherein the step of growing algae comprises:

illuminating the algae in the saltwater by a light source;

controlling a temperature of the algae in the saltwater by a heat source;

regulating a CO2 inflow to control pH of the saltwater;

replenishing saltwater lost due to evaporation and leakage;

regulating a saltwater return inflow for controlling algae outflow; and

measuring pH, algae density, temperature, light source output, dissolved oxygen and micronutrients.

[c37] 37. The method of claim 35, wherein the step of feeding the algae to artemia in saltwater comprises:

providing an inflow of algae and saltwater into the artemia in saltwater;

illuminating the algae in the saltwater by a light source;

controlling a temperature of the algae and artemia in saltwater by a heat source;

regulating a CO2 inflow to control pH of the saltwater;

regulating an oxygen inflow to control dissolved oxygen;

regulating a saltwater return inflow for controlling artemia, algae, waste and saltwater outflow; and

measuring pH, algae density, temperature, light source output, ammonia, dissolved oxygen, waste, and artemia density.

[c38] 38. The method of claim 35, wherein the step of producing artemia by the artemia in saltwater comprises:

consuming algae by the adult artemia to generate small artemia;

filtering the algae, adult artemia, small artemia, waste and saltwater through a screen that allows the algae, small artemia, waste and saltwater to pass as an outflow while restraining the adult artemia.

[c39] 39. The method of claim 35, wherein the step of feeding the algae and the artemia to an immature aquatic specie in saltwater to produce adult aquatic specie comprises:

providing an inflow of algae, artemia, waste and saltwater to the immature aquatic specie in saltwater;

illuminating the algae in the saltwater by a light source;

controlling a temperature of the algae, artemia, waste and saltwater by a heat source;

regulating a CO2 inflow to control pH of the saltwa-

ter;

regulating an oxygen inflow to control dissolved oxygen;

regulating a saltwater return inflow for controlling artemia, algae, waste and saltwater outflow;

measuring aquatic specie density, aquatic specie size, pH, algae density, temperature, light source output, ammonia, dissolved oxygen, waste, volume and artemia density;

consuming artemia by the immature aquatic specie to produce adolescent aquatic specie;

consuming artemia by the adolescent aquatic specie to produce adult aquatic specie; and

filtering the algae, aquatic specie, artemia, waste and saltwater through a graded screen that allows the algae, small artemia, waste and saltwater to pass as an outflow to a filtration means while restraining the aquatic specie.

[c40] 40. The method of claim 35, further comprising positioning habitat structures for increasing the number of aquatic specie in the subsystem.

[c41] 41. An aquaculture system for producing adult aquatic specie, comprising:

an algae subsystem containing saltwater illuminated by a light source for growing algae;

means for flowing the algae from the algae subsystem into an artemia subsystem, an aquatic specie nursery subsystem and an aquatic specie growout subsystem, both containing saltwater;
the artemia subsystem containing adult artemia for consuming the algae and producing small artemia;
means for passing the small artemia from the artemia subsystem to the aquatic specie nursery subsystem containing an immature aquatic specie for consuming the algae and the small artemia and producing an adolescent aquatic specie;
means for passing the adolescent aquatic specie from the aquatic specie nursery subsystem to the aquatic specie growout subsystem for consuming the algae and the small artemia and producing an adult aquatic specie; and
means for harvesting the adult aquatic specie.

[c42] 42. The system of claim 41, further comprising a filtration subsystem for filtering a waste outflow from the aquatic specie growout subsystem and for providing a saltwater return to the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem.

[c43] 43. The system of claim 41, further comprising a data acquisition and control subsystem for controlling the

aquaculture system.

[c44] 44. The system of claim 41, further comprising means for replenishing saltwater lost in the aquaculture system due to evaporation and leakage.

[c45] 45. The system of claim 41, wherein the algae subsystem containing saltwater illuminated by a light source for growing algae further comprises:

a light source for illuminating the algae in the saltwater;

a heater for controlling a temperature of the algae subsystem;

a CO2 inflow for controlling pH of the algae subsystem;

a saltwater replenishment inflow for replacing saltwater lost to evaporation and leakage;

a saltwater return inflow from a filtration subsystem;

an algae outflow to the artemia subsystem; and

measurement means for measuring pH, algae density, temperature, light source output, dissolved oxygen, and micronutrients of the algae subsystem.

[c46] 46. The system of claim 41, wherein the artemia subsystem containing adult artemia for consuming the algae and producing small artemia further comprises:

a light source for illuminating the algae in the salt-

water;

a heater for controlling temperature of the artemia subsystem;

a CO2 inflow for controlling pH of the algae subsystem;

an oxygen inflow for controlling dissolved oxygen of the artemia subsystem;

a saltwater replenishment inflow for replacing saltwater lost to evaporation and leakage;

a saltwater return inflow from a filtration subsystem;

a filter screen for separating the small artemia and waste from the adult artemia;

an artemia outflow to the aquatic specie nursery subsystem; and

measurement means for measuring pH, algae density, temperature, light source output, ammonia, dissolved oxygen, waste, and artemia density of the algae subsystem.

[c47] 47. The system of claim 41, wherein the aquatic specie nursery subsystem containing an immature aquatic specie for consuming the algae and the small artemia and producing an adolescent aquatic specie further comprises:

a light source for illuminating the algae in the saltwater;

a heater for controlling temperature of the aquatic specie nursery subsystem;

a CO2 inflow for controlling pH of the aquatic specie nursery subsystem;

an oxygen inflow for controlling dissolved oxygen of the aquatic specie nursery subsystem;

a saltwater replenishment inflow for replacing salt-water lost to evaporation and leakage;

a saltwater return inflow from a filtration subsystem;

a graded filter screen for separating the immature aquatic specie from the waste algae and small artemia;

a waste outflow to the filtration subsystem; and

measurement means for measuring aquatic specie density, aquatic specie size, pH, algae density, light source output, temperature, ammonia, dissolved oxygen, waste, and volume of the algae subsystem.

[c48] 48. The system of claim 47, wherein the graded filter screen is selected from the group consisting of a planar filter screen and a cylindrical filter screen.

[c49] 49. The system of claim 41, wherein the aquatic specie growout subsystem containing an adolescent aquatic specie for consuming the algae and the small artemia and producing an adult aquatic specie further comprises:

a light source for illuminating the algae in the salt-

water;

a heater for controlling temperature of the aquatic specie growout subsystem;

a CO2 inflow for controlling pH of the aquatic specie growout subsystem;

an oxygen inflow for controlling dissolved oxygen of the aquatic specie growout subsystem;

a saltwater replenishment inflow for replacing saltwater lost to evaporation and leakage;

a saltwater return inflow from a filtration subsystem;

a graded filter screen for separating the adolescent and adult aquatic specie from the waste algae and small artemia;

a waste outflow to the filtration subsystem; and

measurement means for measuring aquatic specie density, aquatic specie size, pH, algae density, light source output, temperature, ammonia, dissolved oxygen, waste, and volume of the algae subsystem.

[c50] 50. The system of claim 49, wherein the graded filter screen is selected from the group consisting of a planar filter screen and a cylindrical filter screen.

[c51] 51. The system of claim 42, wherein the filtration subsystem comprises:

a waste inflow from the aquatic specie growout subsystem connected to an inlet of a pump;

an outlet of the pump connected to an inflow of a first mechanical filter;

an outflow of the first mechanical filter connected to an inflow of a biofilter and an inflow of a second mechanical filter;

an outflow of the biofilter connected to saltwater return inflows of the aquatic specie nursery subsystem and the aquatic specie growout subsystem;

an outflow of the second mechanical filter connected through an inflow heating passage of a heat exchanger to a pasteurization chamber inflow;

the pasteurization chamber pasteurizing the pasteurization chamber inflow from the heat exchanger for destroying living organisms in the inflow, an outflow from the pasteurization chamber connected through an outflow cooling passage of the heat exchanger; and

the pasteurized and cooled outflow from the heat exchanger outflow cooling passage being sent to a saltwater return inflow of the algae subsystem and a saltwater return inflow of the artemia subsystem.

[c52] 52. The system of claim 43, wherein the data acquisition and control subsystem for controlling the aquaculture system comprises:

an input multiplexer for accepting measurement in-

puts from the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem and the aquatic specie growout subsystem;

a microprocessor connected to an output of the input multiplexer, a monitor and keyboard user interface, and an input to an output controller; and

control outputs of the output controller connected to the algae subsystem, the artemia subsystem, the aquatic specie nursery subsystem, the aquatic specie growout subsystem, and the filtration subsystem.

[c53] 53. The system of claim 52, wherein the measurement inputs comprise:

pH, algae density, temperature, light source output, dissolved oxygen and micronutrients from the algae subsystem;

pH, algae density, temperature, light source output, ammonia, dissolved oxygen, waste, and artemia density from the artemia subsystem;

aquatic specie density, aquatic specie size, pH, algae density, temperature, ammonia, dissolved oxygen, waste, volume, and artemia density from the aquatic specie nursery subsystem; and

aquatic specie density, aquatic specie size, pH, algae density, temperature, ammonia, dissolved oxygen, waste, volume, and artemia density from the aquatic

specie growout subsystem.

[c54] 54. The system of claim 52, wherein the control outputs comprise:

heater control, CO2 inflow, saltwater replenishment inflow, light source control, algae outflow, saltwater return inflow, and algae tank flow valves to the algae subsystem;

heater control, oxygen inflow, artemia outflow, light source control, saltwater return inflow, algae inflow, and saltwater replenishment inflow to the artemia subsystem;

heater control, oxygen inflow, waste outflow, light source control, saltwater return inflow, artemia inflow, and saltwater return inflow to the aquatic specie nursery subsystem;

heater control, oxygen inflow, waste outflow, light source control, saltwater return inflow, artemia inflow, and saltwater return inflow to the aquatic specie growout subsystem; and

pump speed control to the filtration subsystem.

[c55] 55. The system of claim 41, further comprising habitat structures positioned within the aquatic specie subsystem for harvesting increased adult aquatic specie.